AMENDMENT

Amendments to the Claims

Please replace all prior versions and listings of claims with the following listing of claims.

LISTING OF CLAIMS:

1. **(Currently Amended)** A computer based method for determining ~~the~~ cavity size in packed bed systems ~~using correlation or mathematical model~~, ~~said~~ the method comprising ~~the steps of~~:

a) ~~obtaining~~ retrieving data parameters related to material properties of ~~the~~ a packed bed system, the parameters including at least: a blast furnace radius (W), an effective bed height (H), a blast velocity (v_b), a tuyere opening (D_t), a void fraction (ε), a gas viscosity (μ_g), a particle size (d_p), a shape factor (Φ_s), a density of gas (ρ_g), a density of solid (ρ_s), a coefficient of wall friction (μ_w), an acceleration due to gravity (g), an effective particle diameter given by $d_{eff} = d_p\Phi_s$, an effective bed density given by $\rho_{eff} = \varepsilon\rho_g + (1-\varepsilon)\rho_s$, a wall-particle frictional coefficient given by $\mu_w = \tan \Phi_w$, wherein Φ_w is an angle of friction between the wall and the particle, wherein D_r is a cavity diameter, and wherein all units are in SI;

b) ~~calculating~~ determining a ~~the~~ cavity radius (R) for both increasing gas velocity and decreasing gas velocity, ~~using mathematical model~~ the determined cavity radius ~~incorporating the stresses/frictional forces~~ given by ~~as~~:

$$2nR^2 - 2nHR + \frac{pn\beta v_b^2 D_T^2}{2\pi^2 M}\left\{\ln\frac{W}{2\pi} - \ln(R - \frac{D_T}{2\pi}\right\} + \left(\frac{2r_o}{M\pi}(\alpha + \beta v_H)v_H(H - r_o) - \frac{F_{wd}}{M\pi}\right) = 0$$

(29)

and

$$2nR^2 - 2nHR + \frac{pn\beta v_b^2 D_T^2}{2\pi^2 M}\left\{\ln\frac{W}{2\pi} - \ln(R - \frac{D_T}{2\pi}\right\} + \left(\frac{2r_o}{M\pi}(\alpha + \beta v_H)v_H(H - r_o) + \frac{F_{wd}}{M\pi}\right) = 0$$

(28)

respectively; ~~or calculating the cavity radius for both increasing gas velocity and decreasing gas velocity using mathematical equations based on correlation as:~~

$$\cancel{\frac{D_r}{D_T} = 4.2\left(\frac{\rho_g v_b^2 D_T}{\rho_{eff} g\ d_{eff} W}\right)^{0.6}\left(\frac{D_T}{H}\right)^{-0.12}(\mu_w)^{-0.24}} \qquad \cancel{(36)}$$

$$\cancel{\frac{D_r}{D_T} = 164\left(\frac{\rho_g v_b^2 D_T^2}{\rho_{eff} g\ d_{eff} H\ W}\right)^{0.80}(\mu_w)^{-0.25}} \qquad \cancel{(33)}$$

~~respectively, and~~

c) ~~calculating~~ determining a ~~the~~ cavity size using the cavity radius obtained in step (b); and

d) storing the determined cavity size in a memory.

2. **(Currently Amended)** A method as claimed in claim 1, wherein the data related to material properties of the packed bed comprise at least: bed height, tuyere opening, void fraction, wall-particle friction coefficient, inter-particle frictional coefficient, gas velocity, model width and particle shape factor.

3. **(Cancelled)**

4. **(Original)** A method as claimed in claim 1, wherein the frictional force (F_{wd}) in equations 28 and 29 is given by:

$$F_{wtd1} = -\frac{4n\pi\mu_w K\,h\,pM}{3\left(1-\frac{\mu_w K}{n\pi}\right)}\left\{\left(r_o - \frac{D_T}{2\pi}\right)^3 - \left(R - \frac{D_T}{2\pi}\right)^3\right\} - 4pn\mu_w K\frac{\beta v_b^2 D_T^2}{4\pi\left(1+\frac{\mu_w K}{n\pi}\right)}(r_o - R)$$

$$+\frac{4n\pi\mu_w K\left(\frac{W}{2\pi}\right)^{1-\frac{\mu_w K}{n\pi}} hpM}{\left(1-\frac{\mu_w K}{n\pi}\right)\left(2+\frac{\mu_w K}{n\pi}\right)}\left\{\left(r_o-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}-\left(R-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}\right\}+4pn\mu_w K\left(\frac{\beta v_b^2 D_T^2}{4\pi}\right) \text{x}$$

$$\frac{1}{\left(\frac{W}{2\pi}\right)^{1+\frac{\mu_w K}{n\pi}}\left(1+\frac{\mu_w K}{n\pi}\right)\left(2+\frac{\mu_w K}{n\pi}\right)}\left\{\left(r_o-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}-\left(R-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}\right\}+\frac{2pWn\pi}{\left(2+\frac{\mu_w K}{n\pi}\right)}\left(\frac{W}{2\pi}\right)^{-\frac{\mu_w K}{n\pi}} \text{x}$$

$$\left\{M-\frac{\alpha v_b D_T}{W}-\frac{\beta v_b^2 D_T^2}{W^2}\right\}\left\{1-e^{-C\left(H-\frac{W+D_T}{2\pi}\right)}\right\}\left\{\left(r_o-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}-\left(R-\frac{D_T}{2\pi}\right)^{2+\frac{\mu_w K}{n\pi}}\right\}+$$

$$W\left(\frac{W+D_T}{\pi}\right)\left\{M-\frac{\alpha_b D_T}{W}-\frac{\beta_b^2 D_T^2}{W^2}\right\}\left[(H-r_o)+\frac{\left\{e^{-C\{H-r_o\}}-1\right\}}{C}\right]$$

5-6. **(Cancelled)**

7. **(Currently Amended)** A method as claimed in claim 1, wherein the packed bed ~~systems include~~ system includes at least one of: a blast ~~furnaces~~ furnace, a cupola, a corex, or a catalytic regenerator.

8. **(New)** A computer based method for determining the cavity size in packed bed systems, the method comprising:

a) retrieving data parameters related to material properties of a packed bed system, the parameters including at least: a blast furnace radius (W), an effective bed height (H), a blast velocity (v_b), a tuyere opening (D_t), a void fraction (ε), a gas viscosity (μ_g), a particle size (d_p), a shape factor (Φ_s), a density of gas (ρ_g), a density of solid (ρ_s), a coefficient of wall friction (μ_w), an acceleration due to gravity (g), an effective particle diameter given by $d_{eff} = d_p\Phi_s$, an effective bed density given by $\rho_{eff} = \varepsilon\rho_g + (1-\varepsilon)\rho_s$, a wall-particle frictional coefficient given by $\mu_w = \tan \Phi_w$, wherein Φ_w is an angle of friction between the wall and the particle, wherein D_r is a cavity diameter, and wherein all units are in SI;

b) determining a cavity radius (R) for both increasing gas velocity and decreasing gas velocity, the determined cavity radius based on dimensionless numbers given by:

$$\frac{D_r}{D_T} = 4.2\left(\frac{\rho_g v_b^2 D_T}{\rho_{eff} g\ d_{eff} W}\right)^{0.6} \left(\frac{D_T}{H}\right)^{-0.12} (\mu_w)^{-0.24} \qquad (36)$$

$$\frac{D_r}{D_T} = 164\left(\frac{\rho_g v_b^2 D_T^2}{\rho_{eff} g\ d_{eff} H\ W}\right)^{0.80} (\mu_w)^{-0.25} \qquad (33)$$

respectively;

c) determining a cavity size using the cavity radius obtained in step (b); and

d) storing the determined cavity size in a memory.

9. **(New)** A method as claimed in claim 8, wherein the data related to material properties of the packed bed comprise at least: bed height, tuyere opening, void fraction, wall-particle friction coefficient, inter-particle frictional coefficient, gas velocity, model width and particle shape factor.

10. **(New)** A method as claimed in claim 8, wherein determining the cavity radius using increasing velocity as given by equation 33 includes using a π-theorem to calculate dimensionless numbers given by:

$$\frac{D_r}{D_T} = 164\left(\frac{\rho_g v_b^2 D_T^2}{\rho_{eff} g\ d_{eff} H\ W}\right)^{0.80} (\mu_w)^{-0.25}.$$

11. **(New)** A method as claimed in claim 8, wherein determining the cavity radius using decreasing velocity as given by equation 36 includes using a π-theorem to calculate dimensionless numbers given by:

$$\frac{D_r}{D_T} = 4.2\left(\frac{\rho_g v_b^2 D_T}{\rho_{eff}\, g\, d_{eff} W}\right)^{0.6}\left(\frac{D_T}{H}\right)^{-0.12}(\mu_w)^{-0.24}.$$

12. **(New)** A method as claimed in claim 8, wherein the packed bed system includes at least the one of: a blast furnace, a cupola, a corex, or a catalytic regenerator.